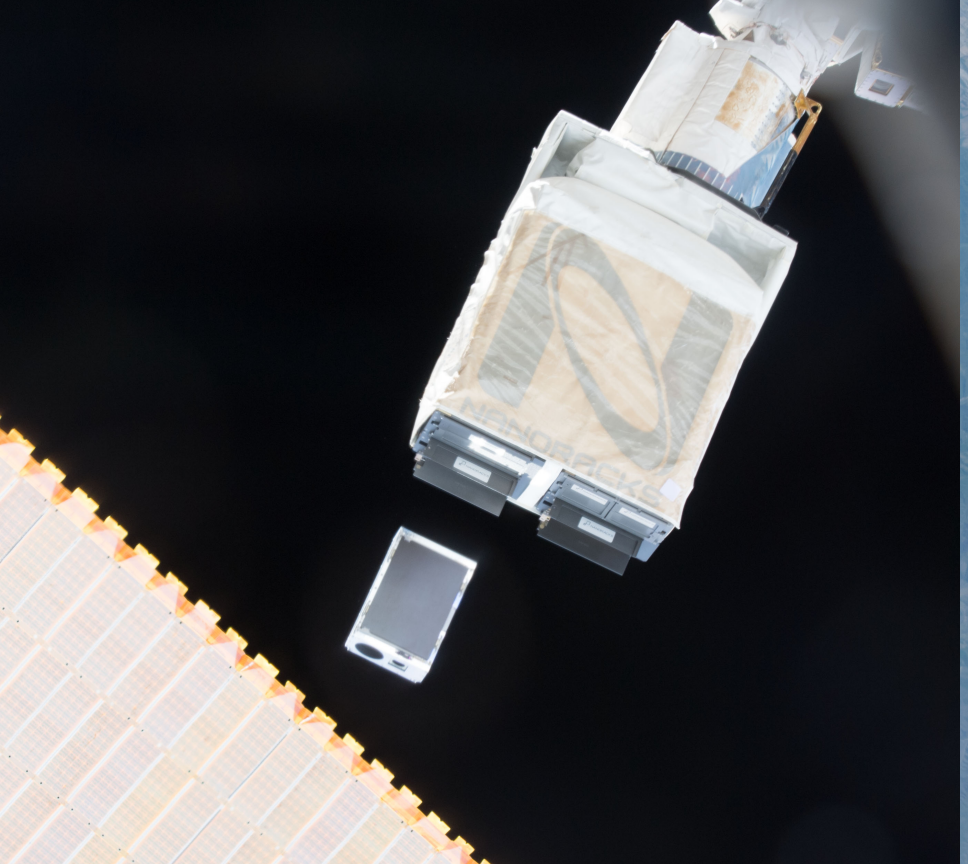


On-Orbit, Subarcsecond Pointing of the 6U ASTERIA CubeSat

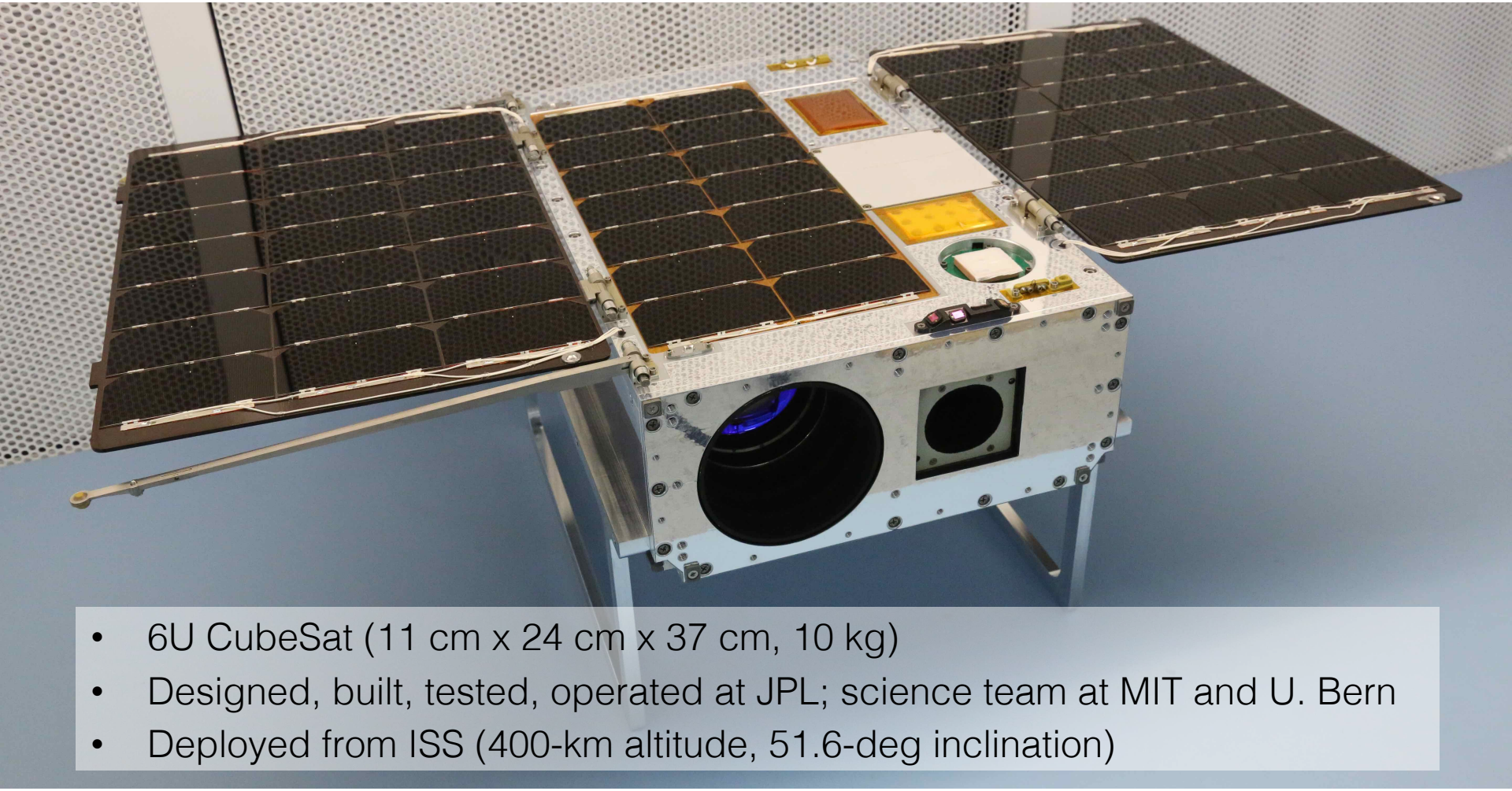
Jet Propulsion Laboratory
California Institute of Technology

Christopher M. Pong

8 August, 2018

ASTERIA Overview

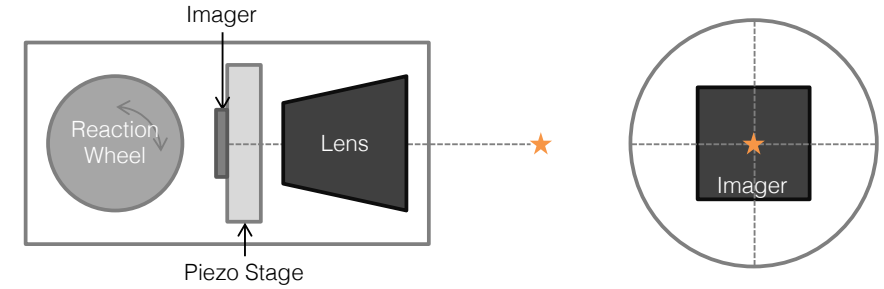
Arcsecond Space Telescope Enabling Research in Astrophysics



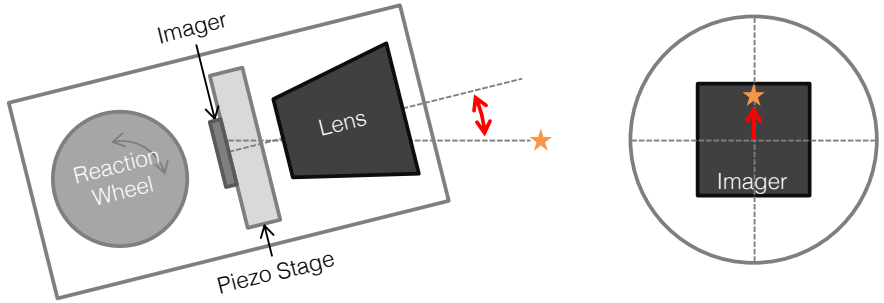
- 6U CubeSat (11 cm x 24 cm x 37 cm, 10 kg)
- Designed, built, tested, operated at JPL; science team at MIT and U. Bern
- Deployed from ISS (400-km altitude, 51.6-deg inclination)

Perform photometry on bright stars, which requires repeatable and stable pointing

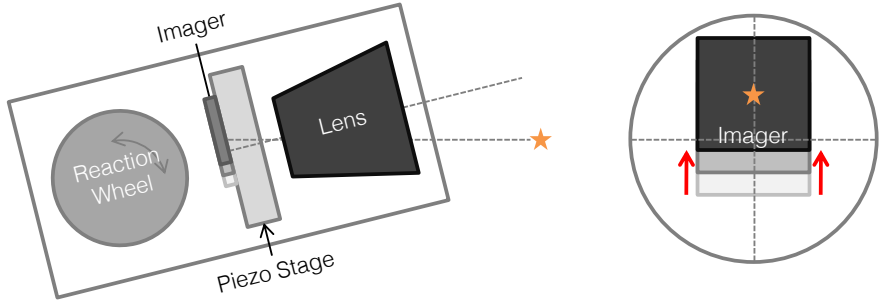
Pointing Control Approach



Reaction wheels point the spacecraft to the target star



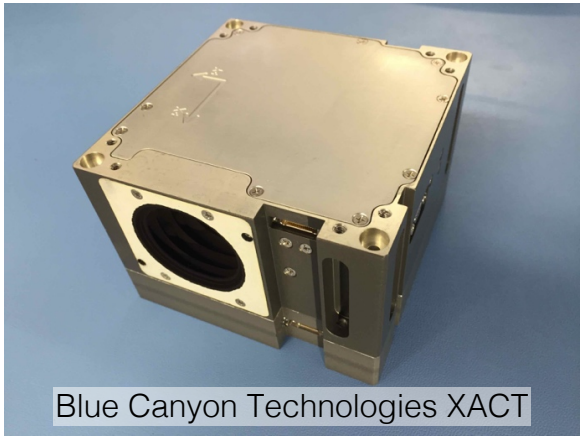
Attitude errors will cause the target star to shift on the imager



Piezo stage shifts the imager to compensate for attitude errors

Two-stage control architecture: Reaction wheels and piezo stage

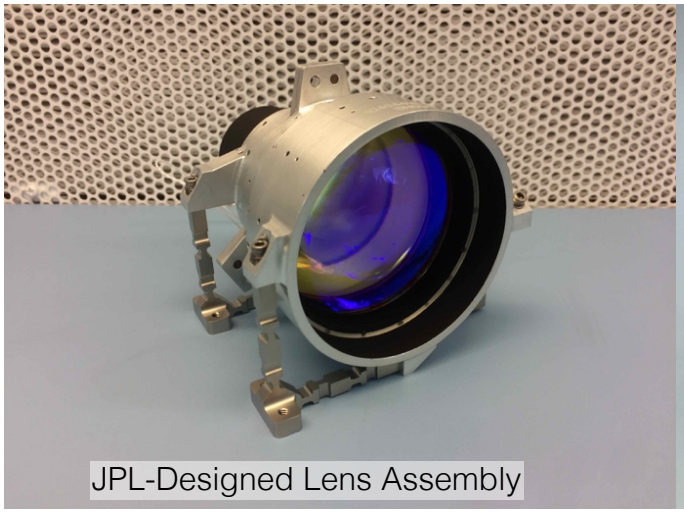
Pointing Control Hardware



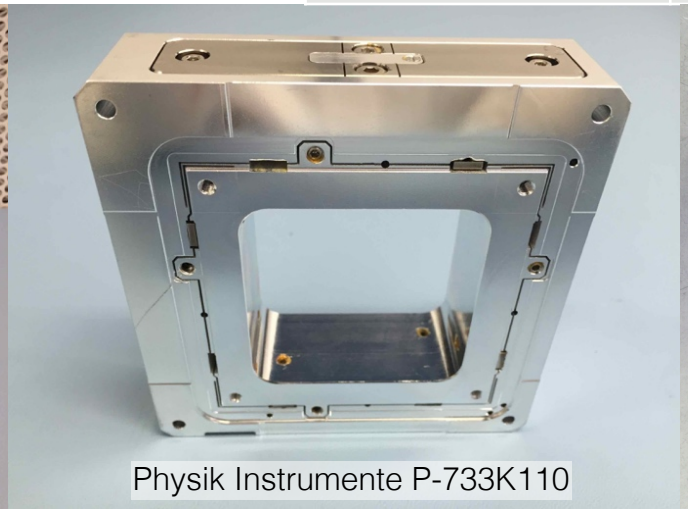
Blue Canyon Technologies XACT

Contains:
- Reaction wheels
- Torque rods
- Star tracker
- Gyros
- Sun sensor
- Magnetometer

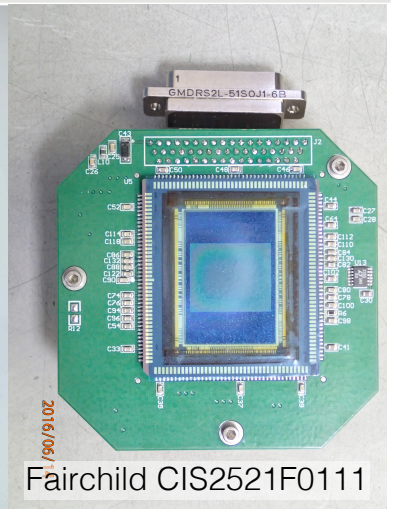
Payload Parameter	Value
Focal length	85 mm
Aperture diameter	60.7 mm (f/1.4)
Format	2592 pix x 2192 pix
Pixel size	6.5 µm x 6.5 µm
Field of view	11.2 deg x 9.6 deg
Plate scale	15.8 arcsec/pix
Piezo stroke	100 µm (240 arcsec)



JPL-Designed Lens Assembly



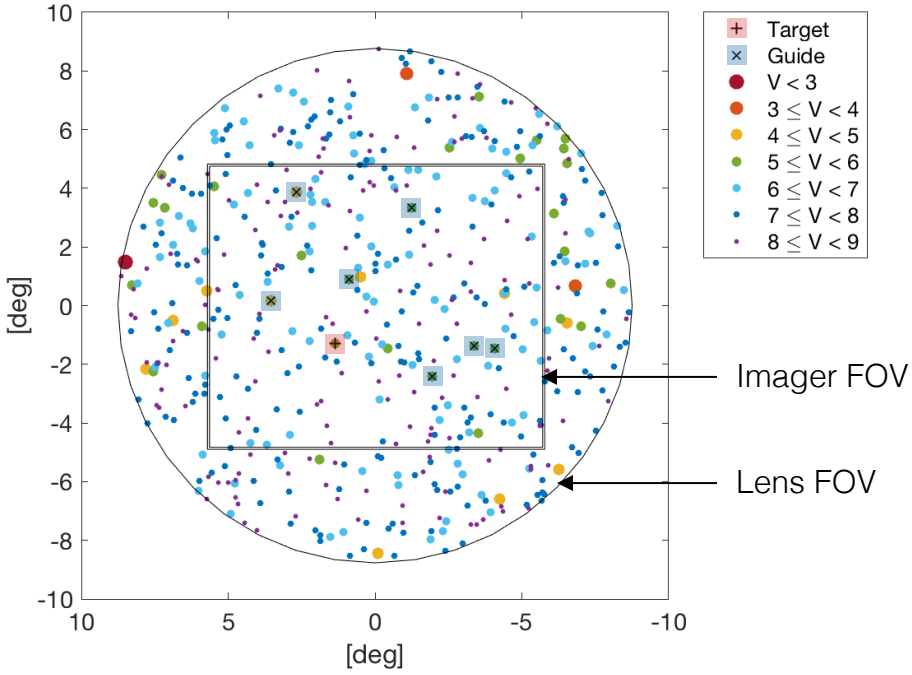
Physik Instrumente P-733K110



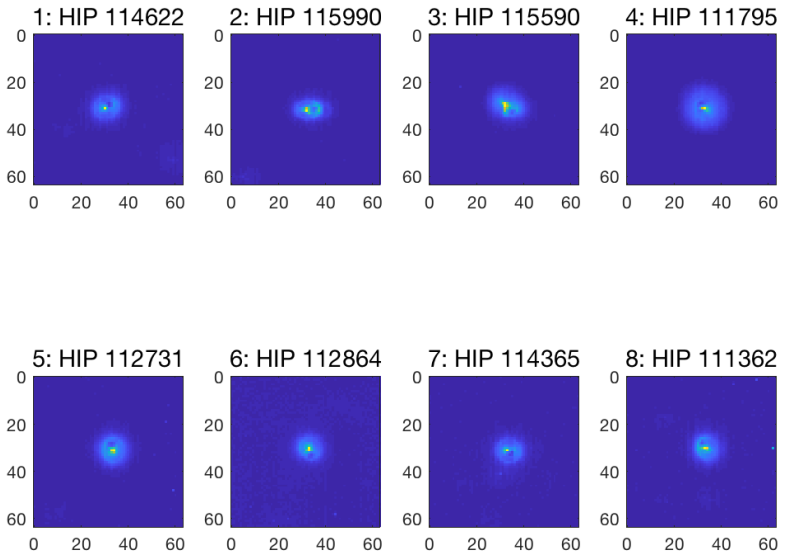
Fairchild CIS2521F0111

Uses a combination of COTS and customized hardware

Focal Plane Array Layout



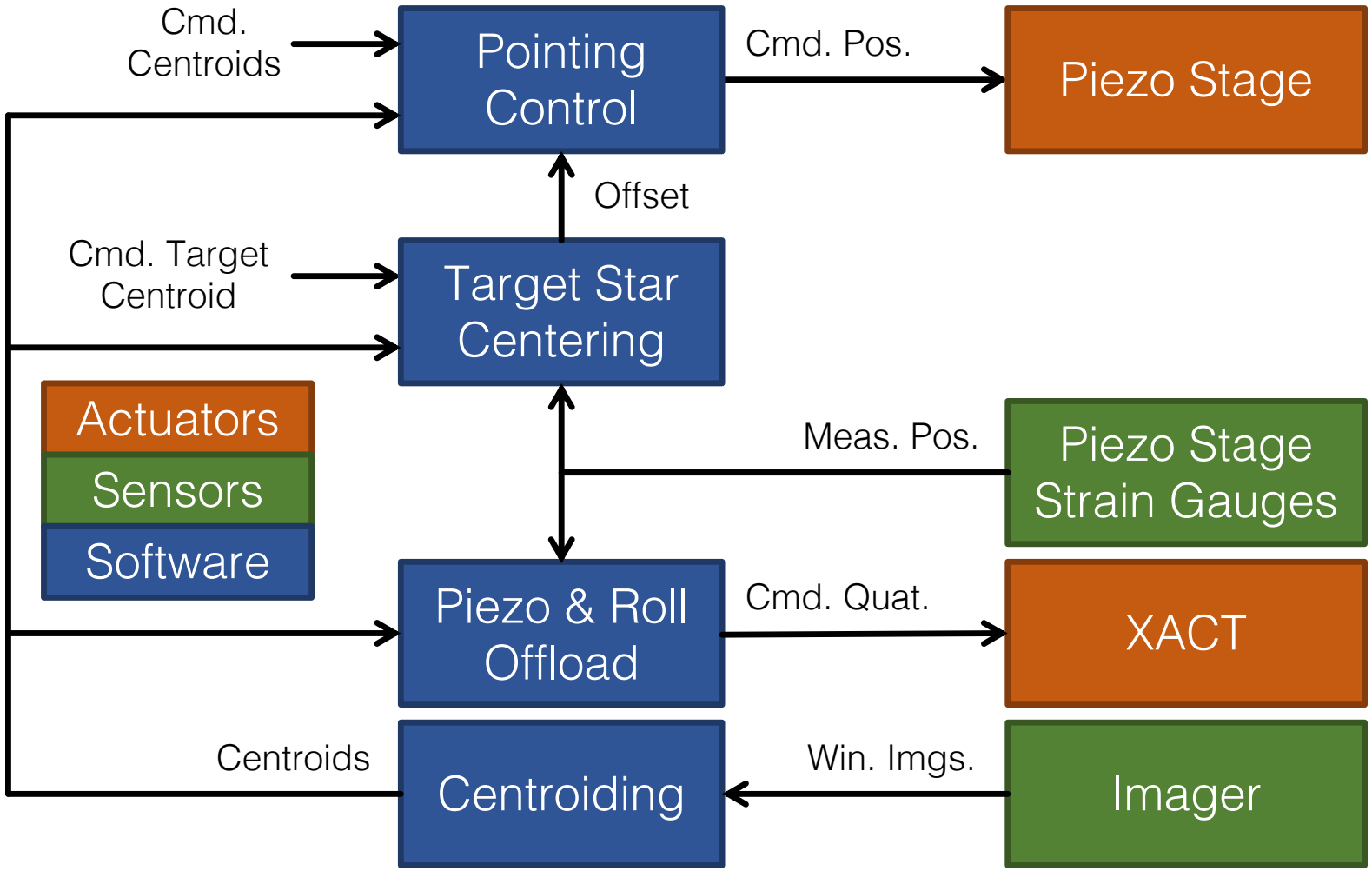
Target and guide star windows on focal plane array



Windowed images of target and guide stars

Windowed images provide sensor feedback for the pointing control loop

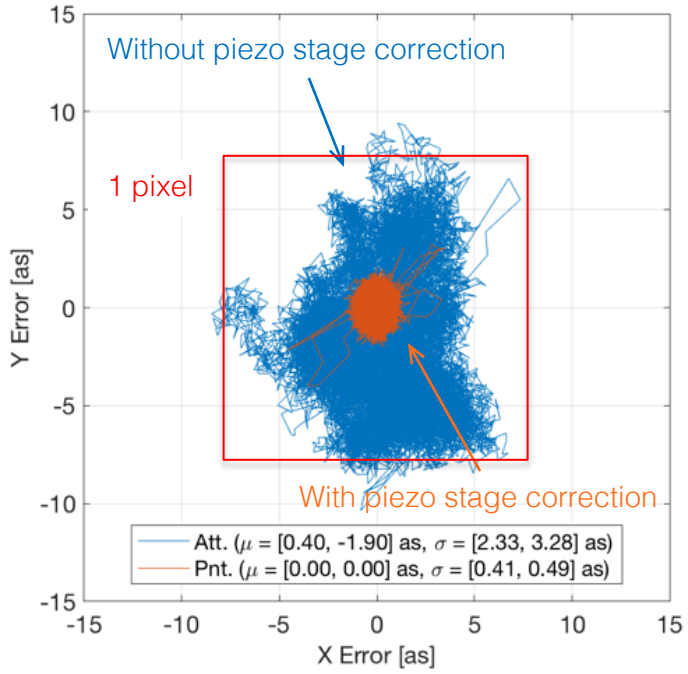
Pointing Control Software Block Diagram



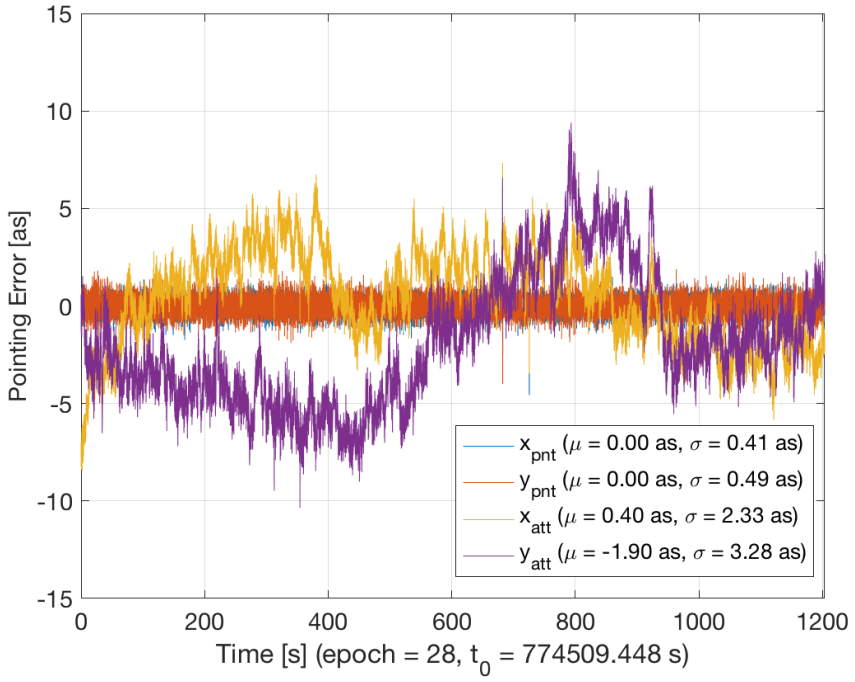
A 20 Hz loop is used to control the piezo stage and command the XACT

Pointing Control Results

Pointing Error over 20 Minutes

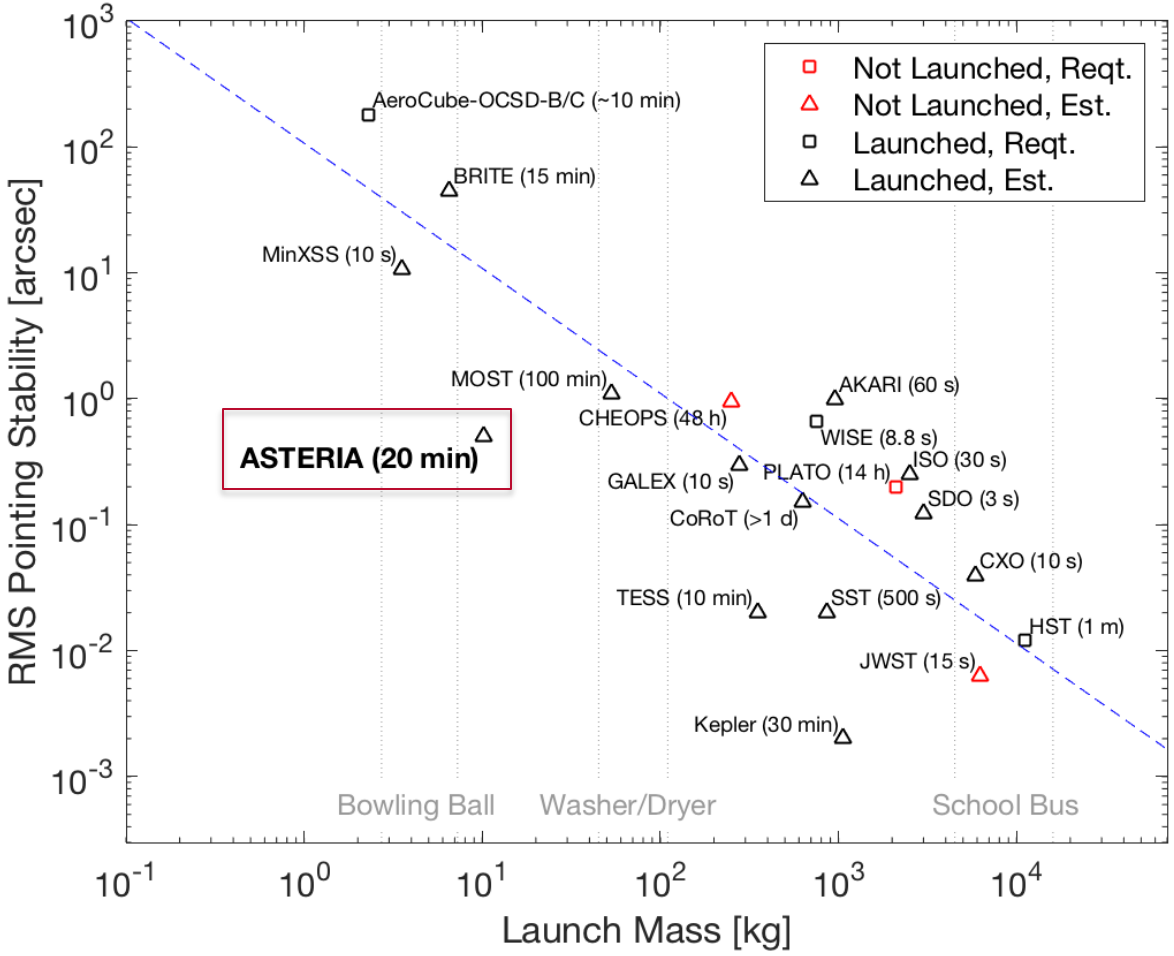


Pointing Error versus Time



Repeatability: 1 mas RMS from observation to observation
Stability: 0.5 arcsec RMS over 20-minute observations

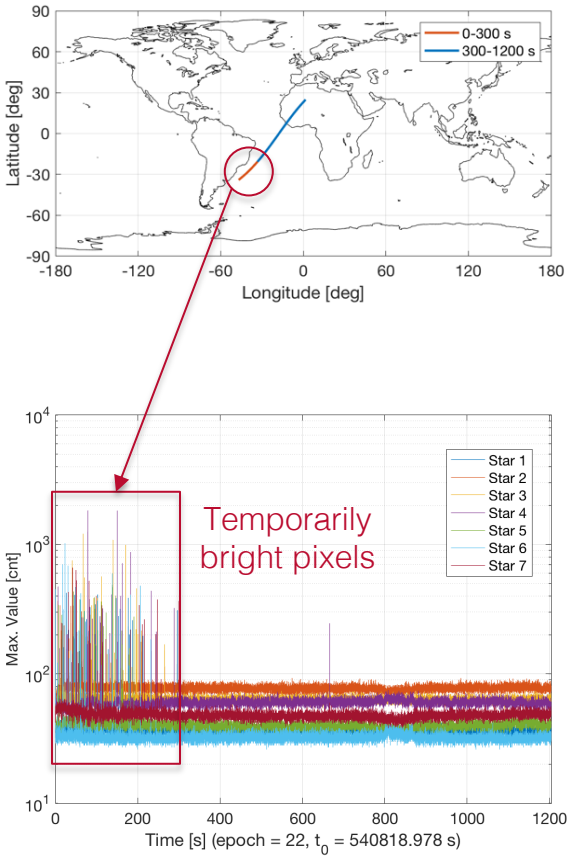
Pointing Stability Comparison



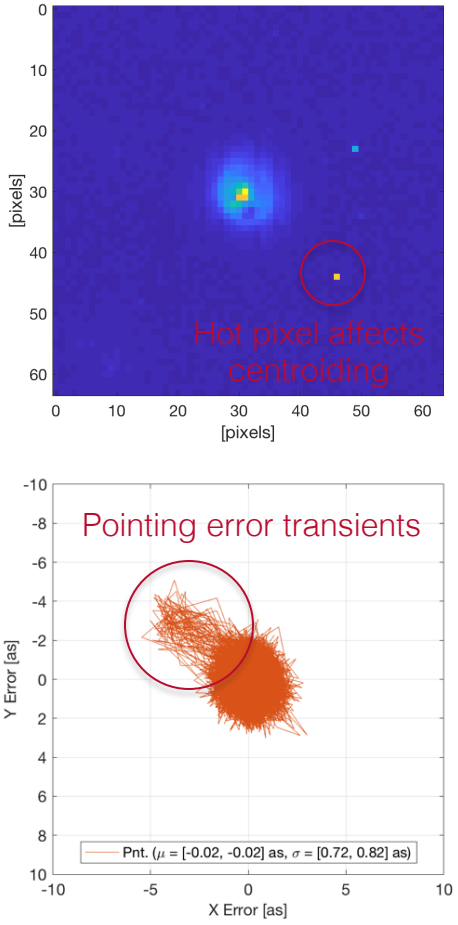
Achieved the best pointing performance to date versus spacecraft of similar size

Pointing Issues Encountered

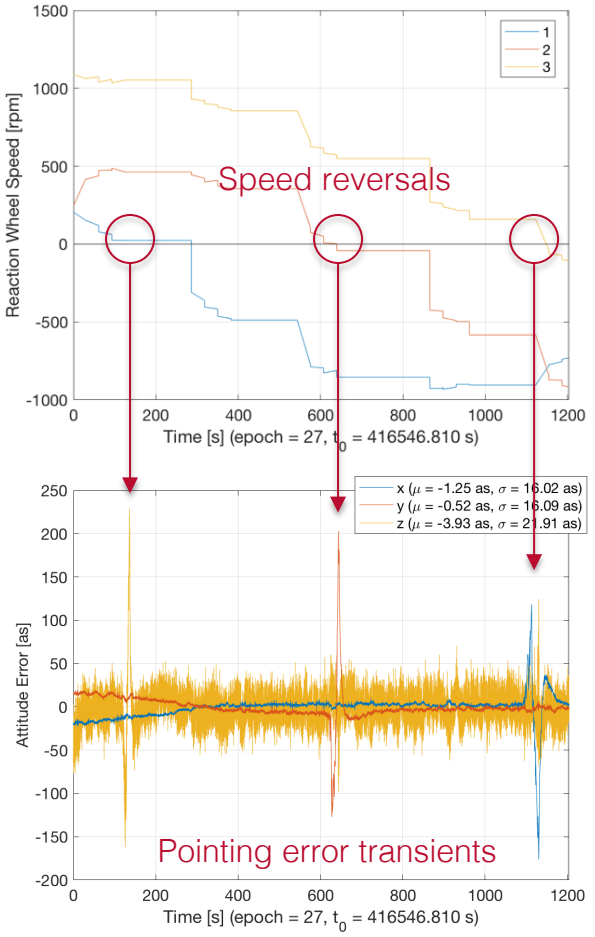
Temporarily Bright Pixels in South Atlantic Anomaly



Hot Pixels



Reaction Wheel Speed Reversals

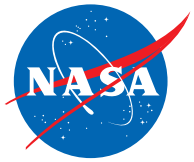


Various pointing issues were encountered and workarounds were developed

For More Information

- Pong, C. M., “On-Orbit Performance & Operation of the Attitude & Pointing Control Subsystems on ASTERIA,” *32nd Annual AIAA/USU Conference on Small Satellites*, Logan, UT, August 2018, pp. 1–20.

- Smith, M. W., Donner, A., Knapp, M., Pong, C. M., Smith, C., Luu, J., Di Pasquale, P., Bocchino, R. L., Jr., Campuzano, B., Loveland, J., Colley, C., Babuscia, A., White, M., Krajewski, J., Seager, S., “On-Orbit Results and Lessons Learned from the ASTERIA Space Telescope Mission,” *32nd Annual AIAA/USU Conference on Small Satellites*, Logan, UT, August 2018, pp. 1–20.



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